Appendix F

AUTOMATED FDC

While the means of technical fire direction is different, the basic operation of an automated FDC is similar to that of a manual FDC.

F-1. Personnel

Duties of the FDO and chief fire direction specialist are the same as in a manual FDC. The equivalent USMC billet description is operations chief.

a. Senior Fire Direction Specialist. The senior fire direction specialist (computer) operates the computer that is the primary means of determining firing data. He is responsible for the transmission of fire commands (voice or digital) to the howitzer sections. The equivalent USMC billet description is operations assistant.

b. Fire Direction Specialist (USMC--Fire Control Man).

(1) Recorder. The recorder maintains the record of fire, recording information as directed by the FDO. The recorder may also be required to operate the computer that is the backup means of determining firing data.

(2) HCO and VCO. The HCO and VCO maintain a firing chart and follow each mission. The HCO and VCO check the coordinates on the firing chart and provide target altitude as required. The HCO and VCO maybe required to operate the backup computer as well.

F-2. Fire Order

The FDO considers the same factors when determining a fire order in an automated or manual FDC. The order in which the fire order is announced and the elements of the fire order are also the same. The biggest difference between the fire order for an automated FDC and for a manual FDC is the SOP. On the basis of the computer's ability to determine individual piece firing data and the computer programs, certain elements would be standardized differently.

a. Adjusting Element/Method of Fire of the Adjusting Element. On the basis of the computer's ability to compute firing data based on individual piece locations, muzzle velocities, and aimpoints, the use of base piece is not necessary (a base piece should be selected for ease of transition from automated to manual). Depending on the computer's programming, it may automatically select an adjusting piece in sequential order, or the operator may have to input an adjusting piece. Method of fire of the adjusting element would be included in the SOP, which may or may not be a programmed computer default.

b. Basis for Corrections. The SOP for this element should reflect the primary means of computing firing data.

c. Distribution. As in a manual FDC, the observer or FDO will announce the sheaf to fire. In a manual FDC, the normal sheaf is parallel. In an automated FDC, the normal or default sheaf will be the default sheaf programmed into the computer.

d. Ammunition Lot and Charge. The SOP for this element will allow the computer to select the lot and charge to fire on the basis of its programmed selection routines. Safety constraints, availability of registration corrections, and muzzle velocity information, are additional considerations when determining the SOP.

e. Target Number. The SOP for this element is normally the next available, as in manual gunnery. The computer may or may not be programmed to automatically assign a target number.

F-3. Fire Commands

Fire commands for automated gunnery are exactly the same as for manual gunnery. Depending on the computer systems in use, fire commands may be transmitted by voice or digitally.

F-4. Establish a Manual Backup for Automated Operations

a. Concept. The manual backup should be set up to allow the automated (BCS and BUCS primary) FDC to continue operations should the computers fail. Manual backup should be established as a form of "position improvement" and should not impede setup or processing with automated means. The manual backup also serves as a basis of rapidly "checking" the automated solution. The basis for the manual backup is that a piece will be designated as the base piece. The location of this piece is plotted on the firing chart. GFT settings are derived by using this piece and reflect its muzzle velocity and TGPCs. Once the FDC converts from automated to manual operations, all adjustments are conducted with the base piece. All ranges are measured from base piece to the center of the target and all data computed reflects base piece muzzle velocity and location. When the observer requests fire for effect, the adjusted data from base piece is converted to data for the **remaining pieces by applying special corrections, or terrain gun position corrections.** These corrections take into account the differences in piece locations (displacement) and the differences in shooting strength (comparative VEs). TGPCs can be determined by using automated means or the Ml 7 plotting board.

b. Establishment of the Manual Backup. The manual backup is established in five steps as follows:

- Select a base piece.
- Construct a surveyed firing chart.
- Determine and apply GFT settings.
- Determine comparative velocity errors for the remainder of the guns.
- Determine position constants.

Table F-1 elaborates on these steps.

Table F-1. Establishing Manual Backup.

STEP	ACTION
1	**SELECT A BASE PIECE.** For ease in the computation of special corrections, the base piece should be a gun close to the center of battery (COB). The piece nearest the center is determined by examining the computer COB and individual gun grid coordinates. Compare the COB grid with each gun grid, and select the gun whose grid is closest to the center of battery. This piece is the base piece, and its location is plotted on the firing chart.
2	**CONSTRUCT A SURVEYED FIRING CHART**. Using the grid determined in step 1, construct a surveyed firing chart. All observer locations, targets, fire support coordinating measures and other locations are plotted as directed by the situation. The procedures for the construction of a surveyed firing chart are in Chapter 6.
3	**DETERMINE AND APPLY GFT SETTINGS**. GFT settings are determined for the shell-charge combinations that the unit may be called upon to fire. A GFT setting can be derived by using automated means. To determine the GFT setting, use the steps in 3a through 3c.
3a	Enter the base piece grid and altitude into the database as an observer.
3b	Select a range near the center of the zone action. Preferably, this should be a met gauge point range from the appropriate GFT.
3c	Process a polar mission by using the azimuth of lay as the direction, the range from step b as the distance, and down 20 as the vertical shift. "Dry fire" shell HE and fuze time with the desired charge. Record the time, deflection, and quadrant. The time is the GFT setting time; the quadrant is the GFT setting elevation. The total deflection correction may be computed by the formula **DEFLECTION FIRED - COMMON DEFLECTION = TOTAL DEFLECTION CORRECTION. TOTAL DF - DRIFT ~ ADJ EL = GFT DF CORR.** **NOTE:** For additional information on the determination of GFT settings, see Chapter 10.
4	**DETERMINE POSITION CONSTANTS**. Position constants must be determined to allow continued accurate firing as weather changes and new met data becomes available. If a registration was conducted, a concurrent met solution is computed to determine position constants. If the five requirements for accurate predicted fire were met by using the computer, a concurrent met may be completed by using the range at which a GFT setting was computed in step 3 above. For detailed instructions on met techniques, see Chapter 11. The FDO must be careful to ensure that the met message used is concurrent with the firing data (GFT setting) used. In an automated FDC, a ballistic met message may not be available. Units should request transmission of a ballistic met to facilitate the ability to isolate position constants that can be used manually.

F-5. Convert a Mission in Progress From Automated to Manual Processing

a. General. Should automated means fail, a battery must continue to process fire missions. With a manual backup established, the FDC continues operations with minimal delay.

b. Procedure. If during the processing of a fire mission the computer fails, the mission is switched to manual processing. If the observer's total corrections are applied to the firing chart, a significant difference in point of impact in the target area may be noticed because of the difference in automated accuracy. To make the transition as smooth as possible, the steps in Table F-2 are used.

Table F-2. Switching to Manual Processing.

STEP	ACTION
1	Alert the observer by voice communication of the change to manual computation. This should make him aware of a possible unexpected change in the location of the impact of the next round. Also he should be aware of the computational aspects of manual gunnery, especially the delay inherent in computation of special sheafs and the possibility of parallel sheaf fire for effect.
2	The VCO uses the GST to determine the site for the fire mission. The VI is determined by subtracting the altitude of the battery from the target altitude determined by the automated system. The range used to compute site is the COB range determined by the automated system.
3	The computer directs the HCO to polar plot the location of the aimpoint of the last correction. To determine the polar plot location, follow steps 3a through 3e.
3a	The computer subtracts the site from the last quadrant computed by the automated system to determine the last elevation computed.
3b	The computer places the elevation gauge line of the GFT over the elevation scale at the elevation determined in step 3a. The computer determines range from the range scale under the manufacturer's hairline. **This range is the polar plot range.**
3c	The computer determines the polar plot deflection by determining drift corresponding to the elevation in step 3b. This drift is added to the GFT deflection correction to determine the total deflection correction for this mission. The computer subtracts the total deflection correction determined from the last deflection computed by the automated system. **The difference is the polar plot deflection.**
3d	The computer announces **POLAR PLOT DEFLECTION** followed by the numerical value of the deflection computed in 3c. The HCO places the vertex of the RDP on the base piece location and orients the RDP to the deflection announced by the computer. The HCO then reads backs the deflection. The computer, on hearing the deflection read back correctly, announces **POLAR PLOT RANGE** followed by the range determined in step 3b. The HCO places a plotting pin in the chart along the arm of the RDP at the graduation representing the announced range. The HCO then reads back the range.
3e	The HCO places a target grid on the target and orients it to the OT direction.
4	The computer records the site computed in step 2 and the total deflection correction computed in step 3c on the record of fire for this mission. The computer determines 100/R at the COB-COT range.
	NOTE: The FDC is now ready to process the subsequent corrections. Subsequent corrections are computed in the manner described in Chapter 9 except that the adjusting piece is changed to the base piece.

F-6. Range K and Fuze K

a. The proportion of correction to range and fuze setting that results from a registration or the solution of a met message is referred to as range K or fuze K. Once determined, range K and fuze K may be used to apply the determined corrections at lesser or greater ranges than that at which the corrections are determined. This procedure allows the application of a "GFT setting" to a TFT.

b. Range K can be determined and applied by using two techniques. These techniques are discussed in Tables F-3 and F-4.

Table F-3. Determining Range K (Technique 1).

STEP	ACTION
1	Determine the range corresponding to the adjusted elevation (Table F of the TFT).
2	Subtract the chart range (range at which the registration corrections were determined) from the range corresponding to the adjusted elevation. The difference is the total range correction. **RANGE ~ ADJ EL - CHART RANGE = TOT RG CORR**
3	Divide the total range correction by the range at which the corrections were determined (expressed in thousands). The result is expressed to the nearest meter and is range K. **TOTAL RANGE CORRECTION ÷ (CHART RG ÷ 1000) = RG K** Once range K is determined, it can be applied to other missions to determine firing data.
4	Divide the chart range to the target by 1000. **CHART RANGE ÷ 1000 = RG IN THOUSANDS**
5	Multiply the result by the range K. This is the range correction. **RG IN THOUSANDS x RG K = RG CORR**
6	Add the range correction and the chart range to determine the corrected range. **CHART RANGE + RG CORR = CORR RG**
7	Enter Table F with the corrected range expressed to the nearest 10 meters. From Column 2, extract the elevation. From Column 3 (M564) or Column 7 (M582), extract the corresponding fuze setting. **This is NOT the fuze setting to fire.**

Table F-4. Determining Range K (Technique 2).

STEP	ACTION
1	Determine the range corresponding to the adjusted elevation.
2	Divide the range corresponding to the adjusted elevation by the chart range. This is expressed to the ten thousandth as range K. **RANGE ~ ADJ EL ÷ CHART RANGE = RANGE K** Once range K is determined, it can be applied to other missions to determine firing data.
3	To apply the range K determined, multiply the chart range to a target by the range K. The result is expressed to the nearest 10 meters and is the corrected range for entry into Table F of the TFT.
4	Enter Table F with the corrected range expressed to the nearest 10 meters. From Column 2, extract the elevation. From Column 3 (M564) or Column 7 (M582), extract the corresponding fuze setting. **This is NOT the fuze setting to fire.**

c. Fuze K can be determined and applied by using two techniques. These techniques are discussed in Tables F-5 and F-6.

Table F-5. Determining Fuze K (Technique 1).

STEP	ACTION
1	Enter Table F of the TFT with the adjusted elevation from the registration. Extract the fuze setting corresponding to the adjusted elevation (use Column 3 for the M564 fuze and Column 7 for the M582).
2	Subtract the fuze setting corresponding to the adjusted elevation from the adjusted fuze setting. The difference is the total fuze correction and can be used as a fuze K. **ADJUSTED FS - FS ~ ADJ EL = TOT FS CORR** **27.5 - 26.7 = +0.8** **NOTES:** **1.** If the registration was fired with a large vertical interval, complementary angle of site will affect the total fuze correction. In this case, the total fuze correction is determined as the difference between the adjusted fuze setting and the fuze setting corresponding to adjusted elevation plus CAS. As a general rule, a large vertical interval is defined as a VI exceeding 100 meters. However, be aware that CAS may have a pronounced effect at lesser VIs. **2.** The total fuze correction may be considered a constant that is applied to the fuze setting corresponding to the adjusted elevation in a fire mission. Once fuze K is determined, it can be applied to other missions to determine fuze settings to fire.
3	Determine the fuze setting corresponding to the adjusted elevation for the fire mission.
4	Determine the fuze setting to fire by applying the total fuze correction (step 2) to the fuze setting corresponding to the adjusted elevation (step 3).

Table F-6. Determining Fuze K (Technique 2).

STEP	ACTION
1	Enter Table F of the TFT with adjusted elevation from the registration. Extract the fuze setting corresponding to the adjusted elevation (use Column 3 for the M564 fuze and Column 7 for the M582).
2	Determine fuze K by dividing the adjusted fuze setting by the fuze setting corresponding to the adjusted elevation. **ADJ FS ÷ FS ~ ADJ EL = FUZE K** Once fuze K is determined, it can be applied to other missions to determine fuze settings to fire.
3	Determine the fuze setting corresponding to the adjusted elevation for the fire mission.
4	Determine the fuze setting to fire by multiplying the fuze setting corresponding to the adjusted elevation for the fire mission (step 3) by the fuze K (step 2). Express the result to the nearest 0.1 increment. **FS ~ ADJ EL x FZ K = FS TO FIRE**